Tanta University | Department: Computers Engineering and Automatic Control | Faculty of Engineering

Total Marks: 30 Marks

Course Title: **Control Systems Engineering**	Course Code: CCE3115	Year: 3rd Comp.
Date: Nov., 22nd, 2014	Allowed time: 75 Minutes	No. of Pages: (1)

Remarks: You must show all of your work -- partial credit may be given to partially correct answers, while answers with no justification may not receive full points. Please attempt all questions.

Note: *There are extra 2 marks that can be used elsewhere to compensate for any loss of marks but the total marks will not exceed 30.*

Attempt all the following:-

In airports, conveyor belts are used to transport both humans and bags. We will study the velocity control for such a conveyor belt. A model for the relation $G_1(s)$ between the control input $u(t)$ and the velocity $y(t)$ is given by:

$$G_1(s) = \frac{1}{(s+0.5)(s+2)(s+5)}$$

Suppose that the total block diagram of the conveyor belts system is as shown in Fig. 1.

a) **Draw the root locus** for the open-loop transfer function to show how the closed-loop system poles changes as K varies from 0 to ∞. **(14 Marks)**

b) From the root locus, determine the value of gain K for **critically damped response** (i.e. damping ratio is equal to unity). **(3 Marks)**

c) Given the value of $K = 15$, **draw the bode diagrams** for the open-loop transfer function of the system. **(9 Marks)**

d) From the bode diagrams, determine the Gain Margin GM, Phase Margin PM, the phase crossover frequency w_{pc}, and the gain crossover frequency w_{gc}. **(4 Marks)**

e) Based on the results of part "d", Is the system stable? **(2 Marks)**

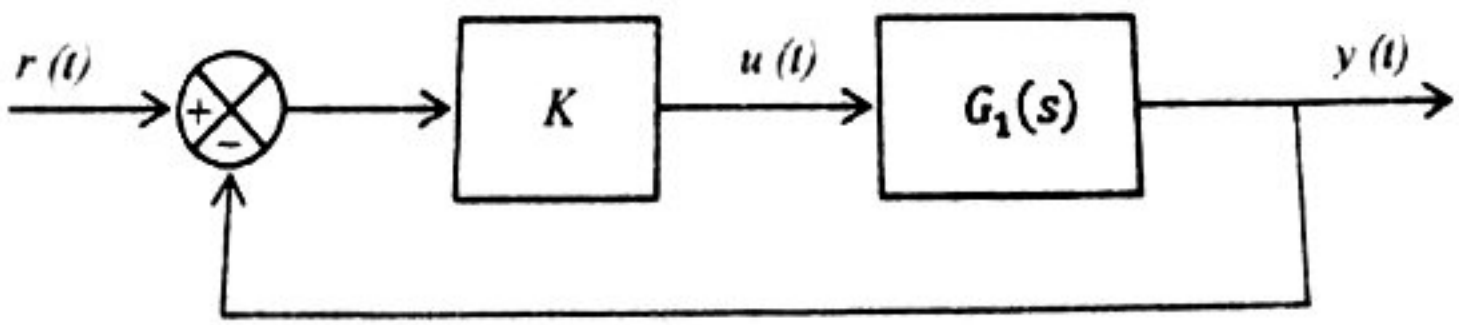

Fig. 1: Block diagram of conveyor belts system